Japanese J. Appl. Statist. 36 (2&3) (2007), 87–98

Approximate Estimate for Exact Logistic Regression

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Abstract

In general, the maximum likelihood method is used to estimate regression parameters in logistic regression model. However, a maximum likelihood estimator does not exist in case of near separation. Furthermore, if the probability of occurring event is extremely small (or large) or the sample size is small compared with the number of regression parameters, a maximum likelihood estimator is not appropriate. In this situation, the exact logistic regression is useful. However, statistical softwares do not always support the exact logistic regression method. Firth (1993) suggested the method to remove bias of a maximum likelihood estimator, but unfortunately, this is not investigated well under near separation. The aim of this paper is to discuss the method to approximate a maximum likelihood estimator or an estimator using Firth's method to an estimator using the exact logistic regression. We also investigate the approximation method with relation to the data structure for improving regression estimates based on simulation study. It is shown that we can approximate a maximum likelihood estimator or an estimator using Firth's method to an estimator using the exact logistic regression. Furthermore, it is possible to improve accuracy of approximation for maximum likelihood estimator if we consider the data structure in the approximation.

Key words: maximum likelihood estimator, exact logistic regression, Firth's method, separation, overlap

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Received March 15, 2007; Received in final form September 4, 2007; Accepted September 11, 2007.